and on the linear transformation of the integral $\int \frac{du}{\sqrt{U}}$.—Prof. Clifford has an excellent paper on the canonical form and dissection of a Riemann's surface. Prof. H. J. S. Smith contributes the conditions of perpendicularity in a parallelepipedal system, and a very interesting presidential address on the present state and prospects of some branches of pure mathematics. Mr. Spottiswoode writes on curves having four-point contact with a triply infinite pencil of curves, and Prof. Wolstenholme gives an easy method of finding the invariant equation expressing any poristic relation between two conics.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Trajectories of Shot

I HOPE you will be able to afford me space for a few remarks on the following extract from a paper on the Trajectories of Shot, by Mr. W. D. Niven, which appeared in the *Proceedings* of the Royal Society for 1877.

Mr. Niven arranges his paper under three heads, calling them the first, second, and third methods. The third method is the one he favours, while he endeavours to dispose of the other two in the following terms :—

"§ 11. It will be observed that the two foregoing methods each open with the same equation (a). Now there is a serious difficulty in the use of that equation. Suppose, for example, we were to integrate over an arc of 1°, we should have to use the mean value of k between its values corresponding to the velocities at the beginning and end of the arc. But we do not know the latter of these velocities ; it is the very thing we have to find. The first steps in our work must be to *guess* at it. The practised calculator can, from his experience, make a very good estimate. Having made his estimate, he determines k. He uses this value of k in equation (a), and if he gets the velocity he *guessed* at, he concludes that he *guessed* rightly, and that he has got the velocity at the end of the arc. If the equation (a) does not agree with him, he makes *another guess*, and *so on till he comes right*."

The case would be indeed hopeless, if all this was quite correct. But I have to inform Mr. Niven that, in all proper cases v_β may be found *accurately* from equation (a), and without any "guessing" whatever. Taking Mr. Niven's own solitary example, I will *calculate* the value of v_β at the end of an arc, not of 1°, but of 3°, and compare my result with his own. The initial velocity, v_α, is here 1,400 f.s., and the corresponding value of the coefficient k_α, given in my table, is 104·0. Substitute this value for k in equation (a), given below, and v_β will be found 1291·7 f.s., a *first* approximation. Now *calculate* the mean value of k between velocities 1,400 and 1,290 f.s. by the help of the table, and it will be found to be equal to 106·3. Substitute this new value of k in equation (a), and v_β will be found 1289·8 f.s., a *second* approximation. We must stop here, because if we attempted to carry the approximation further, we should obtain the same value of k, and therefore of v_β, as in the second approximation. Mr. Niven finds $v_\beta = 1290$ f.s.

Of course in ordinary cases, a calculator, in making his first approximation to v_β, would commence by taking a value of k corresponding to a velocity *somewhat below* the initial velocity. In this way a better *first* approximate value of v_β would be found. Thus, again referring to Mr. Niven's own example, I will take a step over an arc of 6°, from $\alpha = +3°$ to $\beta = -3°$. The initial velocity is 1,400 f.s. I now go so far as to "guess" that the mean value of k will correspond to a velocity considerably below 1,400 f.s., and take $k = 107·9$, corresponding to a velocity 1,300 f.s. This gives $v_\beta = 1208·1$, a *first* approximation. The mean value of k between 1,400 and 1,210 f.s. is now found to be 107·2, which gives $v_\beta = 1209·0$ f.s. Mr. Niven obtains 1207·4 by stepping over two arcs of 3°. If any further adjustment was required, proportional parts might be used, seeing that a correction $\delta k = -0·7$ gives $\delta v_\beta = +1·8$.

Mr. Niven then proceeds to question the *accuracy* of what he is pleased to call the "process of guessing," as follows :—

"It seems to me, however, that this method of going to work, leaving out of account the loss of time, is open to objection in *the point of accuracy*. For, first there is no method of determining on what principle the mean value of k is found—what manner of mean it is. Again, let us suppose for an instant that the velocity at the end of the arc *guessed* at, and the value of k, are in agreement ; that is to say, let the equation

$$\left(\frac{1{,}000}{v_\beta}\right)^3 \sec^3\beta - \left(\frac{1{,}000}{v_\alpha}\right)^3 \sec^3\alpha = \frac{d^2}{w}\frac{k}{g}(P_\alpha - P_\beta) - \text{(a)}$$

hold for the values of v_β and k used by the calculator. It by no means follows that he has hit on the right value of v_β and k. For if he is dealing with a part of the tables in which $\frac{dk}{dv}$ happens to be nearly equal to $-3\frac{wg}{d^2}\frac{\sec^3\beta}{P_\alpha - P_\beta}\frac{(1{,}000)^3}{v^4}$, it is obvious that there are ever so many pairs of values of v_β and k which will stand the test of satisfying the above equation. Now an examination of Mr. Bashforth's tables for ogival-headed shot shows that the value of k diminishes as v increases from 1,200 feet upwards, so that $\frac{dk}{dv}$ is negative for a considerable range of values of v which are common in practice. It is not at all unlikely, therefore, that the value for $\frac{dk}{dv}$ just stated may often be very nearly true ; in which the case the *process of guessing* becomes extremely dangerous."

I here observe that Mr. Niven is not entitled to assume that, because two quantities have the *same sign*, they will therefore be probably often nearly of *equal value*. Without discussing the value of his test of danger, I have to state that my tabular value of $\frac{\delta k_\beta}{\delta v_\beta}$, for velocities above 1,200 f.s., lies between 0 and $-0·09$. I have calculated the numerical values of Mr. Niven's expression for $\frac{dk}{dv}$, for shot fired from various guns, from the Martini-Henry rifle up to the 80-ton gun, and have always obtained a numerical result so far outside the limits of the tabular value, that, for the present, I conclude that Mr. Niven's condition (whatever may be its value) *is never nearly satisfied in any practical example*. But when a practical case is produced where "ever so many pairs of values of v_β and k," *differing sensibly*, "stand the test of satisfying the above equation" (a), it shall receive my best attention.

It is well known that the problem of calculating the trajectory of a shot, like so many other practical problems, does not admit of a direct and complete solution. So that all solutions, being approximations, are more or less erroneous. But I feel perfect confidence in the results given by my methods of calculation, because, the smaller the arcs taken at each step, and the nearer the *calculated* will approach to the *actual* trajectory. But methods of approximation require to be used with judgment. For instance with the heaviest shot in use, we may take steps of 5° for velocities above 1,100 f.s. ; while for small arm bullets arcs of half a degree will be quite large enough. In any case of real difficulty the remedy will be to divide the trajectory into smaller arcs.

From what I have said it appears that my method of finding the trajectories of shot, *when properly applied*, is neither a "process of guessing" nor yet "dangerous."

Minting Vicarage, March 8 F. BASHFORTH

Australian Monotremata

I AM surprised to find that "P. L. S." (vol. xvi. p. 439), was not aware that the Echidna *Tachyglossus hystrix*, is found in N. Queensland. For the benefit of your readers I may mention that the Australian Museum possesses a fine specimen of *T. hystrix* from Cape York. Mr. Armit, of Georgetown, Mr. Robt. Johnstone, and others, have frequently found them in various parts of Queensland. One specimen from Cape York was obtained there by our taxidermist, J. A. Thorpe, in 1867.

The Platypus (*Ornithorhynchus anatinus*) is also found in Queensland as far north as the Burdekin at least, perhaps further.

Tachyglossus, strictly speaking, has no pouch, but the *areola*

is sunk in the skin, and when the young are first born this depression, or miniature pouch, is large enough to hold them; when about a month or so old, their hinder parts may be seen sticking out; when two or three months old, only the head, and afterwards, as they become larger, only the snout is hidden. the marsupial bones, which are well developed, support the weight of the young one while sucking. The young does not leave the mother until at least one-third grown, and *even when fully the size* of the adult, the quills are only then beginning to show through the skin, which is black, and thinly covered with black hair.

The new species, *T. lawesii*, Ramsay, from Port Moresby, may be distinguished at once by the stiff flat bristles of the face and the more cylindrical form of its spines; *T bruijnii* has a very long snout, nearly twice the length of any other species at present known. See *Proceedings* L. Soc. of N. S. W., Vol. ii., Pt. 1. Pl. 1. E. P. RAMSAY

Australian Museum, Sydney, January 25

P.S.—It may interest your readers to know that Messrs. Ramsay Bros., of Maryborough, Queensland, have a fine series of *eleven Ceratodus alive* in a large tank constructed for them. These fish have now lived and thriven well in confinement for over eighteen months. I was the first to send the Ceratodus in spirits to England, although I never got the credit of it; nor did any of those naturalists to whom I forwarded specimens through a friend at the Zoological Society, ever think it worth their while to acknowledge them. Had it been otherwise, living specimens would have found their way to England long since. It is a great mistake to suppose the Ceratodus is now common; they can only be obtained at certain seasons and in certain parts of the Rivers Mary and Burnet. The Osteoglossum (*Barramundi*), with which the Ceratodus (*Tebi ne*) is often confounded, is plentiful enough in the western waters of Queensland.

E. P. R.

Fetichism in Animals.—Discrimination of Insects

I HAVE frequently noticed the fetichism of dogs, and was therefore much interested by Mr. G. J. Romanes' letter of December 27, which I have but just seen. Our terrier—a very queer character and a great warrior—is abjectly superstitious. He will not come near a toy cow that lows and turns its head, but watches it at a distance with nose outstretched. A vibrating finger-glass terrifies him; indeed he has so many superstitions that we often make him very miserable by working on his fears. I feel sure he constantly tries to understand, but never gets further than the sense of "uncanny"-ness. Dogs vary greatly as to this.

A propos of the discriminating power of insects. I have seen humming-bird moths deceived by sight. They were seeking in an open loggia, ceiled with wood, some dark place in which to hide; the pine wood was studded with brown knots. Again and again the two moths flew from knot to knot, felt and rejected them. At last they reached the open work—holes which looked much like the knots—and in them they hid themselves.

I was much struck at the time, as it appeared to me to show they possessed some dim sense of colour, but no defining perception of surface. C. G. O'BRIEN

Cahirmoyle, Ardagh, Co. Limerick

Nitrification

IT seems right to direct attention to the fact that Bacteria were observed by Meusel to convert nitrates into nitrites; an abstract of which observations is to be found in the *Annals and Magazine of Natural History* for February, 1876; this abstract is copied from *Silliman's Journal* for January, 1876, where the reference to Meusel's paper will be found. This reference is *Ber. Berl. chem. Gesel.*, October, 1875.

No indication of their knowledge of these observations is to be found in Schloesing and Munk's paper in the *Comptes Rendus* (February, 1877) or in Mr. Warington's communication to NATURE, vol. xvii. p. 367. F. J. B.

Oxford, March 11

The Wasp and the Spider

MAY I suggest a possible explanation of the curious case of spider-hunting by a wasp cited by Mr. Cecil; had the prey so accurately tracked by the wasp been anything but a spider, it would, indeed, have seemed an almost conclusive instance of hunting by scent; but when one recollects the fine line usually left by spiders as they go, it is evident that sight or feeling may have been the sense exercised, and that the fatal clue may have been the guide to the wasp. E. HUBBARD

March 18

ENTOMOLOGY AT THE ROYAL AQUARIUM

AN aquarium is put to its legitimate use when it is made the home of natural history exhibitions, and any attempt to rescue one from the too dominant sway of the showman deserves every support at the hands of science. The Entomological Exhibition, the opening of which at the Royal Aquarium we noticed last week, is also quite a novelty, though it is the outcome in a particular branch of the idea that led to the Loan Exhibition of Scientific Apparatus at South Kensington; as in that case the exhibitors are induced by no hope of prizes, but merely from the love of their science to lend their treasures. One learns from such an exhibition as this how much genuine love for natural history exists amongst men whose daily lives are devoted to manual labour, and that there are those who live within sound of Bow Bells, who make as good a use of their more limited opportunities as Edward in Banffshire. Here is a Mr. Machin, compositor by trade, whose long day's work has not prevented him from collecting and rearing a magnificent series of crepuscular and nocturnal moths, shown in twenty beautifully-arranged cases and accurately named; and the collections of some others are scarcely less noticeable in this respect. But apart from the interest attaching to some of the exhibitors, the material brought together affords an opportunity both to the entomologist proper and to the general naturalist not often to be met with. The greater portion of the whole exhibition is perhaps inevitably taken up with British lepidoptera, but these are not, as might be feared, an endless multitude of specimens of no special interest beyond their rarity and beauty, but are made to teach as well as please. Lord Walsingham, for example, shows the larvæ, pupæ, and imagines of nearly 370 species with the plants on which they occur—so that we have their complete life-history so far as it can possibly be represented to us. This, perhaps, from its scientific character and the beautiful means of preservation adopted, is the most interesting to the general naturalist, but there are others more limited, but scarcely less instructive—as those shown by the Messrs. Adams, in which the usual parasites are included in the series with each insect. Other instructive collections are those which illustrate the varieties of a single species; such is the set of specimens of *Colias edusa*, exhibited by Mr. Harper, a grand series showing insensible passages between perfectly distinct colourings. The influence of climate on colour is well illustrated in the melanic northern varieties of several species of moths, which are usually of a lighter colour in the south of England, the two varieties being placed side by side in the Yorkshire collections, and the results of selective breeding in the same direction in the photographs, unfortunately not specimens, of the common gooseberry moth, varying from nearly white to almost entirely dark. The moths and butterflies of the fen districts, which are now becoming so scarce, are represented by a very large collection by Mr. Farn. But one of the most interesting objects is a large white close-set web, in appearance like a cloth—some eight feet by four feet, spun by the larvæ of a moth, *Ephestia elutella*, that feeds on chicory. It is a portion only of a larger web, six times the size, formed on the walls and ceiling of a chicory warehouse in York, by the incessant marching to and fro of the well-fed larvæ. The threads composing it are less than $\frac{1}{3000}$ inch in diameter, and as they are nearly contiguous and eight or ten deep, the portion exhibited represents about 4,000 miles of their wanderings. When twisted into a rope, it has been made to support a